



STATE & PRIVATE FORESTRY FOREST HEALTH PROTECTION SOUTH SIERRA SHARED SERVICE AREA



Report SSSA 11-15

Date: September 12, 2011
File No. 3420

**To; Kevin Elliott, Forest Supervisor, Sequoia National Forest.
Rick Larson, District Ranger, Kernville RD, SQF.**

Re: An evaluation of the proposed Sirretta Road salvage based upon our knowledge of biology of the insects and pathogens that attack red fir, and over ridden by a desire to protect the road using public from Hazardous Trees.

SUMMARY: *This report has four parts; first there is a review of the biology of the insects and fungi that impact the biology of red fir, followed by a model which brings all these biologies together. The third and forth parts consist of; a summary of the principles that go into a science/probability based Hazard Tree Mitigation program, and finally there are a few images depicting some of the scenarios that will face tree marking crews. It is hoped that this approach will provide some guidance to field staff and result in the best available decisions being made on the ground.*



Figure 1. A Hazard Tree situation exists when there is a defective tree and a target within range. While this image was not taken along Sirretta road it could have been, and is being used as a framework upon which to build a discussion.

Part I The Biological Background

When we look at a scene like figure 1 we are seeing the final action of several living agents which, while acting for the benefit of the individual organism, may have had their impact in conjunction with other organisms and even abiotic events such as winds and snow loadings. For simplicity we will break out the major scene impacting organisms as dwarf mistletoe, *Cytospora* canker, fir engraver, the flatheaded borer, and Heterobasidion root disease, and after discussing them separately combine them into a single working model, the “*Manion Decline Spiral*”

Dwarf mistletoe (*Arceuthobium abietinum* f. *sp. magnificae*) is the most prevalent damage agent observed on red fir. The mistletoe is a parasitic plant that puts its roots into the branches of the fir and absorbs both water and nutrients from its host. Witches’ brooms were found in occasional large trees, indicating very old infections. When trees are heavily infected, dwarf mistletoe will reduce diameter and height growth, ultimately resulting in mortality. Infections perpetuate when measures are not taken to mitigate spread or intensity of the disease. The parasitic nature of dwarf mistletoe is known to increase moisture stress and predispose hosts to attacks by fir engraver (Ferrell 1974, Berryman and Ferrell 1988) or pathogens – particularly *Cytospora abietis*. As the mistletoe is an obligate parasite; if the branch is dead the mistletoes is also dead. Dead branches can not have living mistletoes on them. A prudent parasite does not, as a rule, kill its host. In the case of this parasite, it kills its host one branch at a time. Before the parasitic plants die they will have produced seed and shot them off to infect new branches. While we may see the final impact of infection, in the form of *Cytospora* killed branches, less obvious may be the new infections of branches in whorls immediately above the highest killed branch. The trajectory of most mistletoe seeds will take them in an arc to lower branches in the same tree or to shorter adjacent trees. However, a small number of seeds will be shot upwards to infect higher whorls of branches. In this way the parasite moves up in the tree as the tree grows in height.

Cytospora canker (*Cytospora abietis*) is a weak parasite that commonly attacks branches previously infected by dwarf mistletoe. This canker-causing fungus can kill young trees or treetops, while only branches are killed on larger hosts (Scharpf 1993). This pathogen is a normal component of true fir ecosystems. Along Sirretta road *Cytospora* infections were as severe as any we have seen on either the Stanislaus or Sequoia Forests. Dead branches killed by the *Cytospora* are potential hazards for drivers and recreationists that frequent this area. While we were stopped along the road (making our observation) a large dead limb fell out of a green fir and landed just a few feet from our vehicle.

While the published literature frequently refers to *Cytospora abietis* as a weak pathogen (Wood *et al*, 2003) it is never the less both a ubiquitous and a very successful pathogen. *C. abietis* owes its success to the presence of the fir dwarf mistletoe. The dwarf mistletoe haustoria (feeding roots) induce swellings on fir branches and upon the death of the mistletoe plants the wounds created by their roots, in turn provide the entry courts for the germinating *Cytospora* spores. The parasitic mistletoes deprive the branches of resources and allow the weak pathogen, *Cytospora*, to become established. Once established, the fungus causes cankers which lead to flagging and branch death. Like many weak pathogens the *Cytospora* ensures its survival by being a prolific producer of spores.

Fir engraver (*Scolytus ventralis*) is the primary bark beetle found infesting the red and white firs. We observed several spike topped firs that had presumably been previously attacked by this insect. Many pieces of downed fir displayed the xylem engraving characteristic of this insect, which indicates that this stem had been attacked when it was both alive and upright. Fir engraver attacks can be found scattered across the landscape, since they select hosts that are typically under severe stress due to lack of moisture or other debilitating condition. Outbreaks of fir engraver usually occur after periods of drought (Furniss and Carolin, 1992). Based on risk-rating systems for red and white firs in Northern California, trees with ragged crowns and low live crown percentages are at highest risk for attack (Ferrell 1980), and we observed plenty of trees that would fit this description. Primary causes of poor crown conditions were frequently attributed to prior dwarf mistletoe and

Cytospora infection. Top-kill and terminal breakage by fir engraver subsequently creates hazardous situations, especially during heavy windstorms and again we saw several of these along the road edge.

Flatheaded fir borer (*Phaenops drummondi*) Although we never found this insect in our brief investigation we have frequently found it in sites like the Sirretta site and would expect it to be present at low levels or to show up in the future. For this insect has a record of being found in association with, heavy dwarf mistletoe, *Cytospora* infection, and fir engraver activity on stressed fir trees.

Heterobasidion root disease (*Heterobasidion irregulare*). What was once known as the “S” type of *Heterobasidion annosum* (aka Annosum root disease) has had its name changed once more and the new taxonomy can be found at Otrosina & Garbelotto (2009). This fungus is unquestionably the most important disease of true firs in the Sequoia National forest. On the Sequoia, Eldorado and Stanislaus forests this disease is at epidemic proportions where ever red or white firs are found. In parts of the 3 mentioned forests this disease is driving species conversion away from fir and towards the pines (upon which it can not feed). At Sherman’s Pass just a few miles from the Sirretta site we observed fir stands where aerial sketchmappers had reported tree mortality at a rate of about 1- 2 trees per acre per year. Upon investigating on the ground we found *Heterobasidion* was indeed killing 1-2 mature trees per acre per year, and had been doing it for so long that it was driving the site to a Jeffrey pine composition (with scattered Lodgepole). Our observations along Sirretta road revealed that although the last winter’s weather events had placed a large volume of wood on the ground, that debris overlay earlier debris from *Heterobasidion* root disease centers. This root disease decays the interior of the root system of the trees and eventually places the trees under water stress thus making them less able to produce defensive chemicals and subsequently the trees become attacked by the fir engraver.

Like *Cytospora canker*, *Heterobasidion irregulare* which is also a poorly competitive fungus, compensates for its deficiencies. *H. irregulare* makes use of the fir’s tendency to root graft to provide it with away to avoid competition with other fungi. Once inside a root system of one fir’s root system the fungus has a way to reach the root system of the next fir without having to come into contact with other fungi. The weakest point in the *Heterobasidion* life cycle is the stage when the fungal spore has to gain entry to a new host via a wound. Fresh stump wounds are only receptive for a few minutes to a few hours, after which time the stump has either dried out or become colonized by other fungi. Thus the approach forest pathologists take to beat this fungus is to block it at the stump surface, by applying a thin layer of an approved Borate formulation (Sporax or Cellu-Treat), that will dry out the delicate spores. The evolutionary strategy of the fungus is to respond by producing vast quantities of spores over many years (perhaps decades). While the probability of any one spore becoming established is vanishingly small the astronomic numbers of spores that can be produced compensate for this low probability. The stump shown in figure 2 measured 5 ft by 6 ft and may well have been cut over a decade ago. Upon reaching inside the stump the *H. irregulare* conk (shown on top of the stump), was found. The conk was found deep down inside the stump and was attached to roof of a hollowed out root. Despite the heat of the day the cavity within the stump was cool moist and humid. Thus the fungus was growing under conditions ideal for spore production. The centre of the stump (which had once been the roof of a wooden cave) had fallen in and produced a chimney through which the fungal spores could now escape. Despite the fact that most of the stump had been decayed away many years ago, the conk was still producing spores, because of root grafting the conk was still being fed by the active decay in an adjacent tree’s root system.



Figure 2. A decade old stump that was still producing spores from the arrowed conk, and having them escape via the circled chimney.

“Spatial and Ecological Analysis of Red Fir Decline in California using FIA data.” is the title of a MS thesis by Lief Mortenson (a graduate student of Professor Dave Shaw of OSU). Mortenson (2011) concludes (based on FIA plots) that California is losing red fir at the rate of 2.64% per annum. Further, Mortenson (2011) concludes that *Heterobasidion* root disease exacerbates the deleterious impact of the dwarf mistletoe.

In part II we will bring together the biology of these separate organisms into a single working model to explain the working of the red fir ecosystem in decline.

Part II Bringing the separate Biologies into a Single Model

Our ground survey revealed that the red fir deterioration along Sirretta Road due to a number of interacting stressors, which include but was not limited to: wind damage, snow loading, old age, stand structure, dwarf mistletoe, the fir engraver, the fir flatheaded borer, *Cytophora* canker, *Heterobasidion* root disease and the after effects of a prolonged drought. The decline model / concept that best explains what we observed is the “Decline–Disease Spiral, proposed by professor Paul Manion (1991). The Manion Spiral (Figure 3) suggests that a tree species can go into a decline spiral if one representative of each of three sets of stressors is acting upon the species. It was Sinclair (1965) who first divided stressors into 3 categories; **predisposing factors** (i), **inciting factors** (ii) and, **contributing factors** (iii). The decline spiral predicts that a species can go into decline if there is first a factor that will predispose the tree to a decline, followed by an inciting factor to trigger the decline and, finally a contributing factor that could eventually kill the tree. While the model predicts that a tree can go into decline with only one factor from each of the 3 sets is acting upon the tree, in most documented decline examples there have been several factors from each of the sets acting upon the declining trees.

The corollary to the Manion Decline Spiral (which is not often cited) is that should one of the sets of factors be mitigated early enough then the spiral should unwind and the tree should recover. However it is impossible to reverse wind or snow breakage. For the purposes of evaluating red fir decline the relevant stressors thought to be active on the on the Sequoia National Forest have been tabulated below (table 1).

Following the above Manion model, the dwarf mistletoe infections are viewed as being the predisposing factor, the drought and *Cytospora* infections were the inciting factors that triggered the accelerated development of damage polygons and the contributing factors that lead to tree death are viewed as being the insects, fungi and weather factors.

Tree mortality is a natural part of a healthy forest! As professor Manion has often said ***“There is a healthy amount of disease in a healthy forest!”*** The decline spiral can only be invoked when there is a mortality level that is significantly above historic or background levels. In the Manion quote, ***“There is a healthy amount of disease in a healthy forest!”*** the word ***“disease”*** should be replaced with the word ***“death”***, for insects can kill trees as easily as fungi.

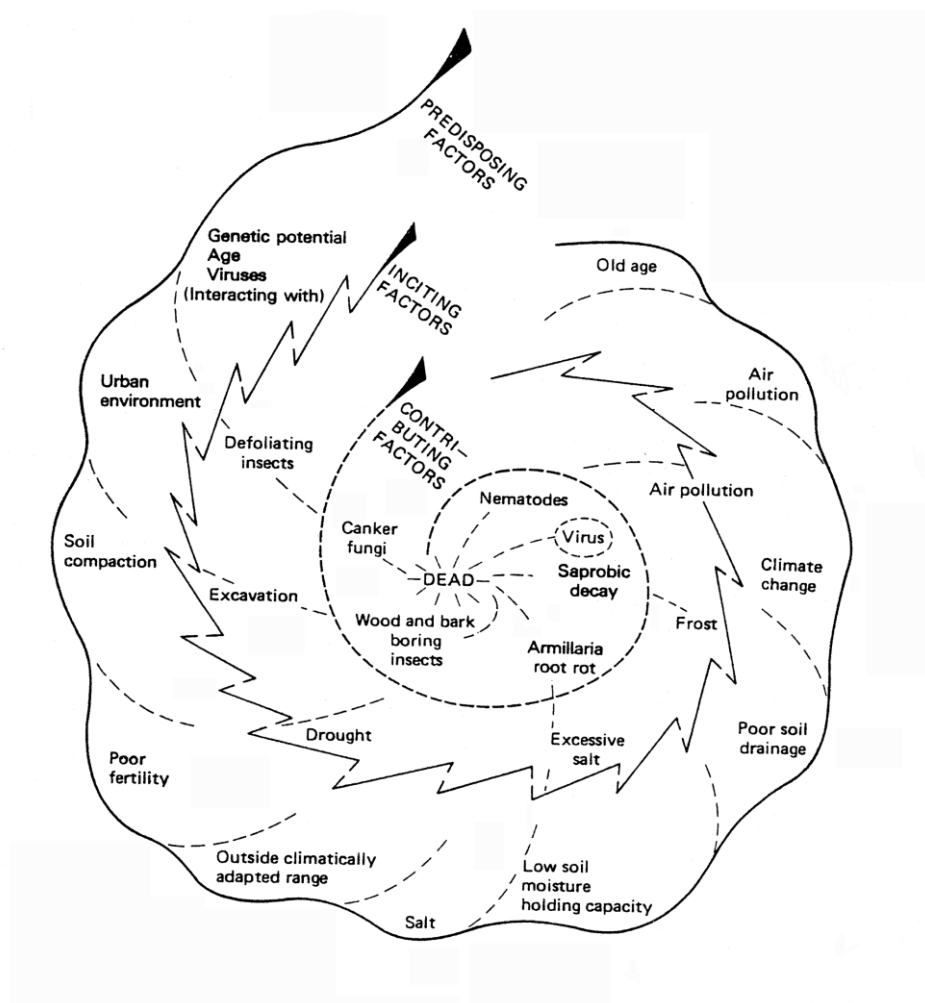


Figure 3. The Manion Decline Spiral, showing the 3 sets of stressors and most of the factors that could play a role in the complex that makes up an individual tree species decline.

(I) <i>Predisposing factors</i>	(II) <i>Inciting factors</i>	(III) <i>Contributing factors</i>
Dwarf mistletoe Stand structure Tree age Climate Change	Drought Cytospora canker Adverse weather events defoliating insects	Flatheaded borer Fir Engraver Heterobasidion root disease Snow loading Wind events other bark beetles etc.

Table 1. The stressors acting upon red fir along Sirretta Road on the Kernville Ranger Districts of the Sequoia National Forest tabulated into the Sinclair Classes as used in the Manion Decline Spiral model, with the major stressors highlight in yellow.

Part III An Overlay of the biology based guidelines to manage the risk associated with Roadside Hazard Trees

Section III has drawn heavily on an earlier document that was drawn up for roadside Hazard Trees on the Hume Lake RD of the Sequoia National Forest. The rationale for doing this is simple; the biological basis for Hazard Tree Mitigation does not change between Ranger Districts. However, the complexity of individual situations may change the fine details of how the risk is managed. We are not trying to eliminate risk we are demonstrating that we (US FS) are prudent and wise in our management of risk. Consider figure 1, which was not taken along Sirretta Road, (Sirretta Road looks a lot worse than the image above). There are 2 ways that we can eliminate the risk associated with visitors driving their vehicle along the road photographed in image 1, unfortunately neither is acceptable to the US FS. The unacceptable solutions are close the road or clearcut and regenerate the stand. The only acceptable solution is to initiate a roadside salvage and remove all trees that are expected to die before the next management operation.

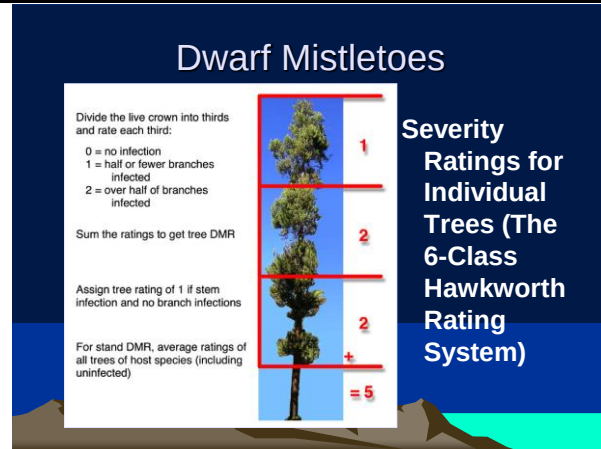
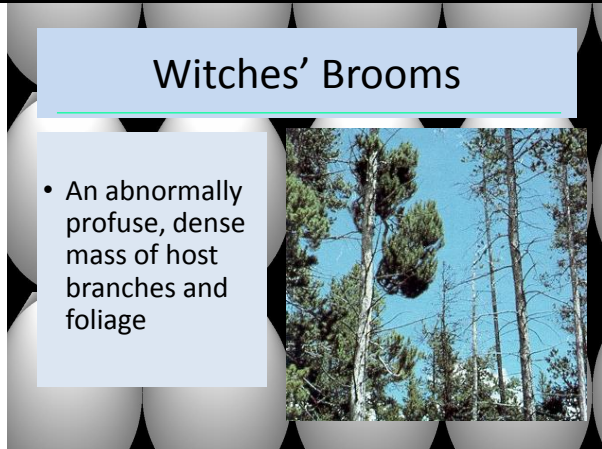
Although the Californian Regional Forest Health Protection guidelines for roadside salvage is still in draft status, as soon as they are finalized we will place them on the www and E-mail links to all relevant staff within the Shared Service Area. In the mean time we direct your attention to the R06 guidelines, which are available at; <http://www.fs.fed.us/r6/nr/fid/> After opening this page scroll to the bottom to find “other website of interest” and there you will find links to “[Danger trees](#)” and “[Hazard trees](#).” As there has long been a strong spirit of cooperation amongst western region pathologist the final R05 guidelines will not be significantly different from the R06 guidelines.

While no pathologist can tell just when a dead tree is going to fail, all pathologists will tell you that a dead tree can not heal itself. In fact no tree can heal itself; all a tree can do is seal over a wound. Fire scars are never healed they are just sealed over. This approach to Hazard trees has led some pathologist to declare that “**Dead wood is not negotiable**” it must be removed if it is within the target zone. For the purposes of this project the target zone is one tree height from the road. Where the trees are shorter the target zone is narrower. Adopting this approach the forest need not consider the possibility of a domino effect from a bark beetle kill spot or a root rot pocket is at the edge of a stand. After a one tree height buffer strip has

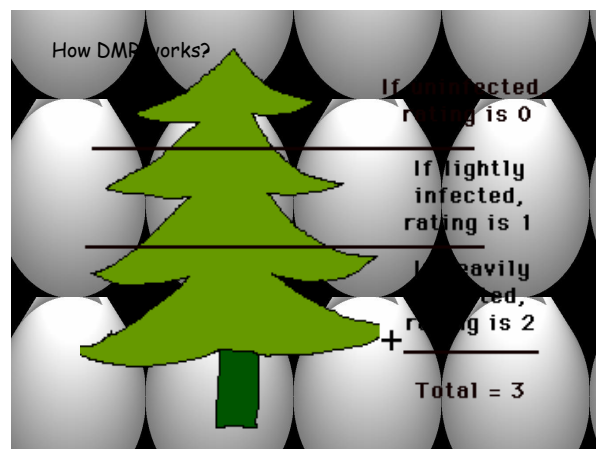
been cleared other root rot and bark beetle kills could be left in the stand, because they can not cause a domino effect that could reach the traveling public.

In a recent survey of Red Fir Decline in California Mortenson (2011) concluded that the rate of red fir decline had increased in recent years and that at the individual tree level now reaches 2.64% per annum. He identifies the red fir dwarf mistletoe as the single most important factor contributing to this mortality. Mathiasen *et al* (1990) working in Douglas fir concluded that the mortality level in stands heavily infested with dwarf mistletoes was 3-4 times as high as in healthy stands. When drawing up guidelines for managing another non-broom forming mistletoe, the gray pine dwarf mistletoe, Pronos *et al* (2004) suggest preferentially removing DMR trees rated 5 or 6. The preponderance of pathological advice suggests that it would be prudent and wise to remove trees with a Hawksworth Dwarf Mistletoe Rating of 5 or 6. As the true fir dwarf mistletoes rarely induce brooming a strict application of the DMR system will underestimate the severity of mistletoe infestations in true firs. However when, retired Pathologist, John Pronos drew up earlier guidelines he compensated for this underestimate by requesting firs with more than half of their crown already dead be removed. Below, we suggest strengthening the biology of his logic by using *Cytospora* infections as a surrogate for mistletoe infections.

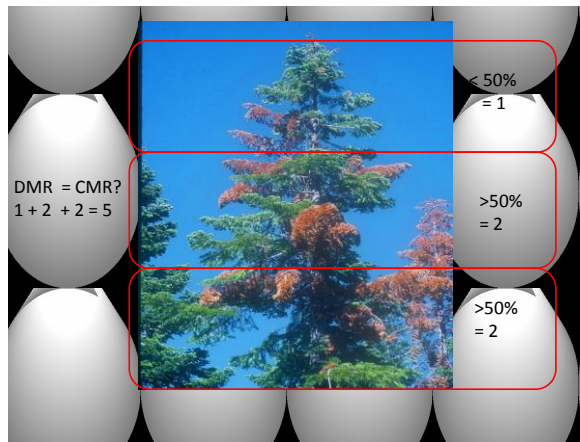
As dwarf mistletoes on red fir rarely induce brooming the Hawksworth DMR system needs adapting.



On a Douglas fir or Ponderosa dwarf mistletoes induce brooming and this brooming led to the development of the well known 6 Class Hawksworth DMR system (Hawksworth, 1977)



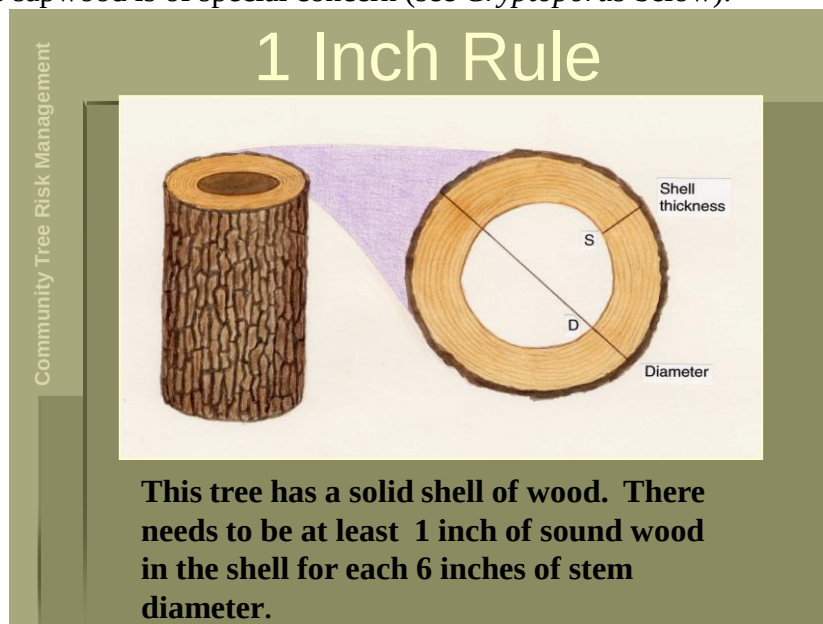
But, on red fir the Dwarf mistletoe rarely induces brooming and thus the system is difficult to apply. For this reason we suggest using *Cytospora abietus* induced flagging as a surrogate for mistletoe induced brooming. This becomes a *Cytospora* / mistletoe rating system.



It is well known that in those species where the dwarf mistletoes induce brooming trees that rate a Hawkworth 5 or 6 are definite hazards. We know that the *Cytospora* flagging develops on branches that were previously dwarf mistletoe infected (Scharpf & Bynum, 1975) and thus we are suggesting that in red fir trees in which more than half of the crown is already dead should be considered for removal. However the final decision to remove a tree should be based upon an evaluation of the top 25% of the crown (See part IV below)

The threat posed by heart rot columns.

In many cases a hollow pipe can support as much weight as a solid rod of the same outside diameter (Pokorny, 1992). It has generally been accepted by most regions that the critical cut off for most hazard tree situations is the point where the shell thickness is less than $1/6^{\text{th}}$ of the diameter. This is expressed in the one inch rule (see below). As this shell or outer cylinder is made up of sapwood any decay fungus that preferentially decays sapwood is of special concern (see *Cryptoporus* below).



Should the bottom of the pipe be open (as in the image below) it is recommended that the required shell thickness be doubled.

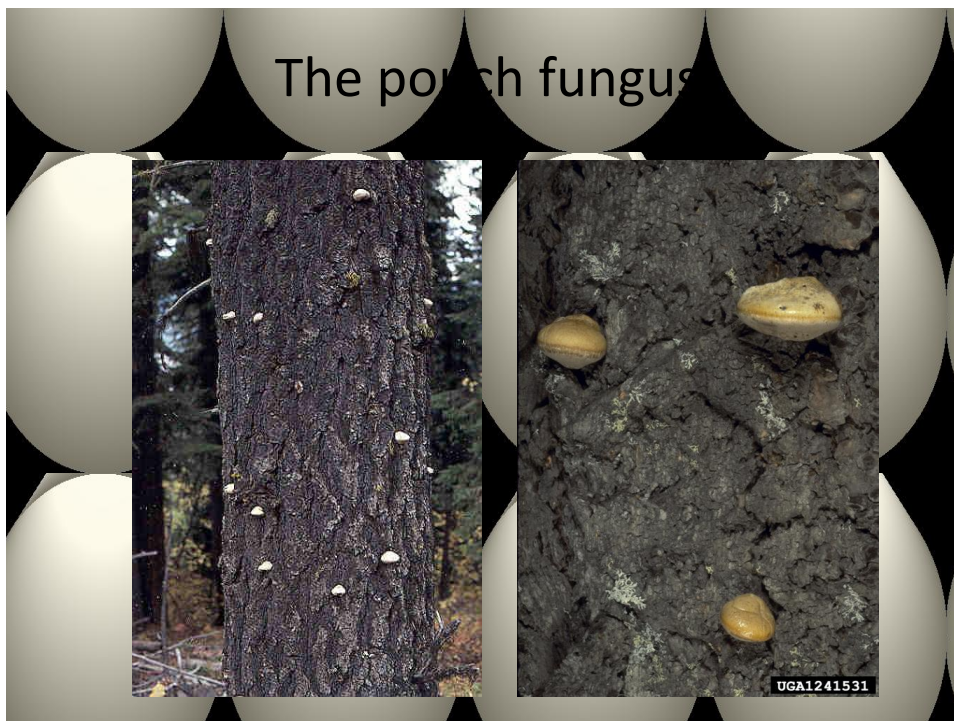
2 Inch Rule



This tree has an opening in the shell. If an opening in the stem is 30% of the stem's circumference, the shell needs to have at least 2 inches of sound wood for each 6 inches of stem diameter.

The pouch fungus

While above are the basic rules used in most regional hazard tree guidelines they do not take into account the decay caused by the pouch fungus, *Cryptoporus volvatus* (image below). The pouch fungus is a sap rot fungus and thus it preferentially attacks the outer sapwood cylinder, the very wood we count upon to provide the strength. Thus we would make a blanket recommendation that any tree with conks of the pouch fungus be removed, for the fungal fruiting bodies are a sign that the sapwood is probably already decayed.



Dead tops and steep “V” crotches.

In situations where bark beetles have killed the top of a tree we recommend the trees removal, provided the tree is closer to the target (road) than the length of the dead top. Even although it may be less than a tree height from the road a dead topped tree can be retained, so long as the distance to the road is greater than the length of the dead top. A similar argument can be made for multiple leadered trees that have a steep crotch angle and especially if there is evidence of a crack at the fork or bark being included in the crotch. These steep “V’s” have tendency to shear and we feel it would be prudent and wise to remove them.

Pitch Tubes on living trees

Pink to reddish pitch tubes are numerous (>10), and are found over at least 1/3 of the circumference of the bole, at or above 5 feet, and extending at least 10 to 15 additional feet up the bole. The pitch tube criterion specifically excludes whitish pitch tubes that do not have pink or reddish boring dust associated with them and basal attacks by the red turpentine beetle (RTB) which are characterized by very large pitch tubes, associated with coarse boring dust, generally restricted to the lower 2 to 3 feet of the bole.

Boring dust or frass, pouch fungus conks and/or woodpecker activity

Any combination of boring dust or frass (in bark crevices, webbing along the bole, or that accumulates at the base of the trees), pouch fungus conks and/or current woodpecker activity (holes into the sapwood and/or bark flaking, specifically excludes injury caused by sapsucker feeding) present over at least 1/3 of the bole circumference. Specifically excludes these indicators when only associated with wounds, old fire scars, etc., or when woodpecker activity is restricted to the lower 2 to 3 feet of the bole.

Active crown fade

At least 50% of the live crown exhibiting current, active, contiguous, crown fade or dieback from the top or throughout the mid to upper crown. Specifically excludes older top-kill with very few or no needles remaining.

Scattered branch dieback

Scattered branch mortality from *Cytospora*/dwarf mistletoe infection where 50% or more of the live crown has been recently killed and the remaining live crown ratio is less than 30%.

Part IV A Discussion and a photo-essay of images from Sirretta Road.

This section was added because we are aware that the Hawksworth-Cytospora-Mistletoe rating system is difficult to apply and; it would be possible to mark for removal too many trees. Thus we came up with an additional marking guideline to specifically to prevent over enthusiastic marking. We recommend that no tree that has the top 25% of its crown, intact, fully developed, and free from major flagged branches be removed, unless it possesses some other hazard characteristic which by itself would be enough to condemn the tree. This characteristic might include, but is not limited to, sprung roots, missing a large number of roots, lacking adequate shell, a lean, a major or horizontal crack, a weak union, etc. We came to this conclusion after walking sections of the road and trying to grade trees. Additionally we looked at our photographs and tried to do a marking. Our conclusion is; that if all dead and snapped trees are first marked for removal and then the most obvious hazard trees are added to the mark there will be remarkably few borderline trees left. It appears that the weather damage was so intense that most trees in ill health were snapped or blown over.

Convention used in the next few images.

Dead tree Remove 
Living tree retain 
Living tree Remove 

We justify the removal of this living tree on the grounds that, in our professional opinion this tree will not live much longer.

This tree is a western white  and should be retained unless it contains an unacceptable defect. Although our cruise was not complete we saw no Western Whites suffering from blister rust and encountered none that appeared to be Hazards.



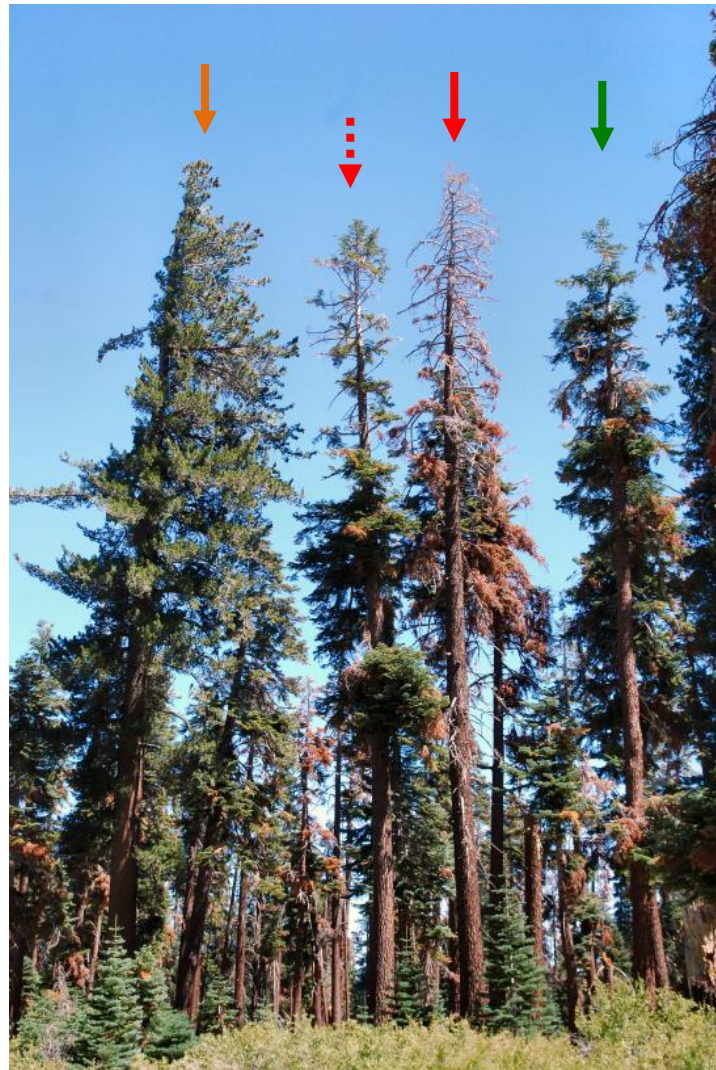
It must be remembered as we closer to the base of a tree the less of its upper crown we can see and hence we would be inclined to overestimate the amount of Cytospora in it.

Had the green tree been a Douglas fir in a mistletoe infested stand it would have been marked for removal. Had this tree been growing outside the roadside buffer zone it could have been retained as a wildlife tree



The double headed white arrow shows a forked top and the length of the arrow indicates the distance from the road that the tree has to be for it to be considered a hazard. Provided first the fork union is declared unsound. In this image the forked tree was not a Hazard it was too far from the road. Had the top been killed by the fir engraver the same ruling would apply.

This image was provided at a larger size to point out that the living tree that was marked for removal has already lost a lot of its crown and most of that loss was in the upper portion so necessary for continued health. Care must be taken to separate the view of the tree crowns from trees that might be behind the subject



Upper crown unimpacted by *Cytospora*, but is it being impacted by the Dwarf Mistletoe¹?

¹ Post Production enlargement of the top of this image revealed at least 9 mistletoe plants

Middle crown once impacted by mistletoe, currently being killed by *Cytospora*.

Lower crown long since killed by *Cytospora*

With the aid of a telephoto lens a 12 megapixel image was taken of the top few feet of a, still *Cytospora* free, red fir pole. Using the image at maximum resolution it was enlarged and examined using the photo-software Paint Shop Pro. Clearly visible dwarf mistletoe plants were marked with stars and the image reduced to a manageable size. Fourteen of the most obvious mistletoe plants were starred. It is offered here to make the point that; although we are using the *Cytospora* induced flagging of previously mistletoe infected branches as a surrogate for a DMR we may be still underestimating the presence of red fir dwarf mistletoe in the individual tree.



A portion of the image, provided above, enlarged to more clearly show living mistletoe plants. By the time these plants die and provide entry points for *Cytospora* the terminal will have elongated by several internodes. However, it must be remember that, there may be asymptomatic plants developing internally 1 to 2 branch whorls above the highest currently observable plants.

Other Forest Health Concerns.

While surveying the Sirretta Road area we were impressed with, the health, the size, and number of western white pines we encountered. While we never observed any blister rust flagging we did notice a very healthy ground cover of Ribes bushes. Although blister rust may not be in the area we are aware that this fungus does threaten the survival western white pines, thus we would suggest that in the salvage operation any opportunity to release an individual western white should be taken. However, upon reflection of how open the weather damage has made the stand, this opportunity might not arise very often.

In conclusion.

- Were this road a campground we would not hesitate to recommend closing it. When we visited the site we had contemplated camping at the site so as to be able to make our examination more extensive, but on observing the amount of dead wood we decided against this course of action. A hung limb falling out of a green tree while we were examining stumps for Heterobasidion conks, came as an exclamation point to our earlier decision. Before selecting our lunch site we took extra care to ensure the site was safe. If we would not camp there we cannot let other folk's camp there. Thus we conclude that the "do nothing option" is to "close the road". We observed campfire rings that indicate that the site has been recently used by campers (and in fact we "**briefly**" considered camping there ourselves)
- Having seen the amount of Heterobasidion root disease in this and the surrounding area we conclude that we would be negligent in our duties if we did not stress in the strongest terms that any cutting of live or moribund trees should involve a dressing of an approved borate compound, either Sporax or Cellu-treat. Not to dress the stumps will lead to ever more root disease and potentially the extirpation of red fir locally

An Appendix on Heterobasidion root disease

The most significant disease problem within the National Forests of the South Sierra Service area is Heterobasidion root disease and most of these problems arose from past foresters not understanding the long term implications of their actions. During the time of railroad logging when the focus of forestry was simply timber production, little attention was given to what was then known as *Fomes annosus*. Because the disease was much less prevalent than presently, it was not thought necessary to take preventative actions. After fires or other salvaging operations, forest pathologists were not aware of the problem they were letting develop. As more and more pine was harvested, shade tolerant true firs became more common along with their disease. As the forests became less heterogeneous, and below-ground landscape became dominated by root grafted firs, the fungus grew to be a larger problem. One of the greatest advantage of North *et al*'s heterogeneity (2009) lies in the fact that it will break up the below ground landscape and restrict the opportunity *Heterobasidion occidentale* has to infect new root systems. *H. occidentale* cannot infect living pine root systems or freshly cut pine stumps. Thus if an infected fir is surrounded by pines or cedars, the fungus cannot spread to adjacent root systems. Stand heterogeneity will break the fungus's vegetative spread below ground and timely applications of Sporax® will prevent stump infection by spores (above ground).

It has been argued by some foresters that Sporax® application in a fir dominated stand severely infested with Heterobasidion buys little, because the fungus is already established (below ground) within what is essentially a communal root system. However a sign in your pathologist dentist's office has given him pause to think again.

The sign reads “*You don’t need to floss all your teeth; you only need to floss the ones you want to keep!*” Following the same logic the pathologist would now claim “***You do not need to Sporax all your stumps just the fir stumps adjacent to the firs you want to keep!***” We have already recorded living root grafted stumps associated within the salvage area. While we expect the next 30 -50 years to lead to more fir deaths from Heterobasidion root disease we do not know which root systems are still disease free. Only one or two trees in each small cluster has to live for another 100 to 150 years to provide legacy firs that will become the decadent den / nest or rest / roost trees that GTR 220 promotes. Sporaxing the stumps of salvaged trees is a cheap insurance policy against the uncertainty of the next century.

At the turn of the century and the advent of steam logging, forestry was about producing timber. Today, forestry is about ecosystems management. Back then, we did not appreciate the impact Heterobasidion was to have, as stands were allowed to develop a high fir component. However, we now know what failure to apply an approved borate protectant can lead to, and for these reasons we strongly recommend its use.

The web sites listed below provide links to the most important literature on this disease and the optimal protective measures.

Heterobasidion Information <http://www.fs.fed.us/r5/spf/fhp/heterobasidion.shtml>

- [R5 Insect & Disease Manual: Heterobasidion](#) (pdf 1.9 MB)
- [R5 Heterobasidion Handbook](#) (pdf 98 KB)
- [Cellu-Treat Information, Product Label, and Material Safety Data Sheets](#) (pdf 356 KB)
- [Otrosina Heterobasidion taxonomy paper](#) (pdf 1.5 MB)
- [CA Forest Pest Conditions 2009: Heterobasidion](#) (pdf 2.4 MB)

There is a white paper that should be considered prior to beginning a project-NEPA document. This white paper can be found at :<http://www.fs.fed.us/r5/spf/fhp/pesticide/index.shtml> It is referred to as the pesticide use advisory memorandum 06-01 (two documents on the web page, the cover letter and the attachment (which is the white paper). The attachment responds to Issues Raised by CATs Concerning Borax (Sporax®) and was authored by David Bakke, Regional Pesticide-Use Specialist. There is also a national risk assessment for “Borax” fungicides that discusses human as well as ecological health risks, located on-line at <http://www.fs.fed.us/foresthealth/pesticide/risk.shtml>

While David Bakke (Regional Pesticide-use specialist), Phil Cannon (Regional pathologist) and others have worked on updating the Forest Service regional policy on Sporax®, some of the work is still ongoing and the latest status report can be provided if requested.

Please contact Forest Health Protection with any additional questions or concerns regarding interpretation of these marking guidelines. We do not think these guidelines in any way contradict older guidelines the forest may have used. They were drawn up to augment and further explain the guidelines the forest is using. Additionally, our service area staff is available to provide technical support in defining the boundaries of any root rot centers that may intrude into the roadside buffer strip that has to be cleared of Hazards. The SA staff is available, at short notice, to provide Hazard Tree training for both roadside and campground settings.

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